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"ELASTIC REBOUND" THEORY OF DEEP EARTHQUAKES

A NEW theory of earthquakes which explains why there are so few aftershocks following deep-seated tremors, in contrast to the many which follow "surface quakes," was offered before the Washington meeting of the American Geophysical Union by Dr. L. Don Leet, director of the Harvard University seismograph station.

The theory, the first that explains shocks originating miles below the earth's crust, was made from scientific records obtained in a series of New England shocks last December which Dr. Leet described as the best ever obtained near the center of an earthquake and the most complete ever obtained in New England.

The basis for the new theory was the finding, made in the Harvard Geophysics Laboratory by David T. Griggs, that rocks which flow under tremendous pressures may break, then heal, and then flow again. Previously it had been believed that in the so-called "area of flow," miles deep in the earth where confining pressures are terrific, the rock would remain in a state of flow and would not break.

Dr. Leet's explanation is that in deep quakes, such as those which shook New England in December, the flowing rock material heals quickly after a break and resumes steady flow again, thus producing only a few aftershocks. In surface earthquakes, however, like the San Francisco and Japanese tremors, the break is not healed quickly due to the lack of high pressures, and readjustments occur as hundreds of minor aftershocks. The December quakes in New England, which were centered near Lake Ossipee, N. H., were felt over an area of 350,000 square miles, and though they caused relatively negligible damage, were in the "potentially destructive" class. Even the great San Francisco quake in 1906 was felt over an area hardly greater (400,000 square miles), and he added that had the Ossipee quake been centered in an urban area the damage and casualties would have been great.

In his paper, read by the Reverend Daniel Linehan, S.J., of the Weston College seismograph station, Dr. Leet stated that the Ossipee quake was centered twenty-one miles below the surface, with the area of disturbance extending up to the granitic layer of the crust, nine miles deep. The underground area of disturbance must have had a diameter of more than twenty miles, he said.

According to the new theory, this great underground area at the center of the quake has been subjected for many years to a distorting stress of some kind, in addition to the great confining pressure. Under the distortion, the rock flows continuously until the breaking point is reached. Then the rock breaks suddenly under the strain. This may happen every century or two, and explains the first earthquake at Lake Ossipee on December 20.

The second shock, on December 24, was probably due to a gigantic underground rebound from the first quake. The records indicate that the first shock drove the top of the underground disturbance area up into the elastic granitic crust, which is nine miles deep. Four days later this crust reacted and drove back the rock mass. This is indicated by the fact that on December 20 the quake registered on the Harvard instruments as a great underground "push." The quake on December 24, on the other hand, registered as a "pull" in the opposite direction.

Dr. Leet stated that the theory of the mechanism of earthquakes at the surface, developed at the time of the San Francisco quake, does not explain the deep-seated New England earthquakes. This so-called "elastic rebound" theory explains that the granitic crust is bent, over a period of many years, until it breaks and rebounds into place, causing the earthquake.

Eight seismograph stations collaborated with Harvard in obtaining the data on the Ossipee quakes.

WHITE DWARF STARS

INSIDE the white dwarf stars, like the curious companion of Sirius, the dog star, which is so dense that a cubic inch of its material, though still gaseous, would weigh a ton, no hydrogen is present, according to Dr. R. E. Marshak, of the University of Rochester. He estimates that the temperature deep in such stars is about 10,000,000 degrees.

It is believed that these dwarf stars are made up mostly of "degenerate" gas. That is, instead of being made of atoms, they consist of swarms of single electrons, which are building blocks of atoms. A great many more electrons can be packed in a given space than atoms which are many times larger.

In the process by which the stars are normally kept fueled, nuclei of atoms hit each other and hydrogen is transmuted into helium, with carbon, then nitrogen, then carbon over again, and so on, as intermediate stages. At the high densities of the white dwarfs, if this process were operating, collisions of the nuclei would be much more frequent, and consequently these stars should give off many times as much heat as the sun, yet really their output is considerably less. Dr. Marshak, in explanation, says that there is practically no hydrogen in these stars, except, in a few cases, in an outer shell a few hundred miles thick.

Without hydrogen, he attributes the production of energy of the white dwarfs to contraction. That is, the energy released as the outer parts fall to the center is converted into heat. Proposed nearly a century ago, a similar theory was once given in explanation of stellar energy in general, but it was shown that it would not provide energy for the times over which the stars seem to have been in existence. Dr. Marshak says that it would suffice to keep the white dwarfs going for 100,000,000 years at least, and after that they will become dark objects.

Dr. H. A. Bethe, of Cornell University, whose theory of the hydrogen-helium transmutation as the source of most stellar energy is now generally accepted, also adressed the meeting. Dr. George Gamow, of George Washington Uni-

versity, who presided, spoke on his theory that stellar explosions are due to particles called neutrinos, which have no mass.

THE TRANSMUTATION OF MERCURY

MERCURY has apparently been turned into gold by the cyclotron, or atom-smasher, at Harvard University. This experiment, which may realize the ancient dream of the alchemists, was reported at the Washington meeting of the American Physical Society by Dr. Rubby Sherr and Professor Kenneth T. Bainbridge.

However, the amount obtained was so exceedingly minute that only by an indirect method was its presence shown. Further, it is a form of gold that rapidly vanishes. It decays like radium. With one form detected, after 48 minutes, half of a given amount is gone; after another 48 minutes, half of what remains, and so on. The other forms lasted a few days.

Dr. Sherr and Professor Bainbridge shot heavy hydrogen nuclei, or deuterons, from the Harvard cyclotron, at lithium, from which high speed neutrons were obtained. These, in turn, were used to bombard mercury. A tiny amount of gold was mixed with about a pound of the bombarded mercury. The mercury, being a liquid, was boiled away in a vacuum, leaving behind the gold, which is non-volatile. A chemical process removed small amounts of platinum which were also formed by transmutation of the mercury.

Tests of the gold showed several forms which acted like radium. One was the new kind, with half decaying in 48 minutes. Also were present forms that have previously been found by other means, with half-decay periods of 65 hours and 78 hours. However, since the gold itself had not been subjected to the neutron bombardment, and had not originally shown any radioactivity, it appears that these were formed in the mercury itself. Putting more gold with it, they all joined together, and could be more easily removed. In other words, the additional gold was the bait which drew the transmuted gold atoms to it, so that they could all be pulled out together.

THE GULF OF CALIFORNIA

THE Gulf of California has been a "steady" feature of the American landscape for several million years, Dr. Harald U. Sverdrup, director of the Scripps Institution of Oceanography, stated before the annual meeting of the American Geophysical Union. Studies from the institution indicate that the Gulf "existed in essentially its present form before late Pliocene time," which puts its beginnings well before the last great Ice Age.

It is essentially a long submarine valley, broadly V-shaped in cross-section, caused by the sinking of the earth's crust below sea level. The same sag in the crust runs northwestward into California, dropping below sea level (though without flooding) in famous Death Valley. There have been some additional sinkings here and there in the gulf since it was first formed, producing deep troughs and basins in its floor. Deep terraces along the sides of the Gulf can be explained in part as remnants of the old floor, prior to the development of the inner troughs.

While survey parties afloat have been studying the gulf, Dr. George F. McEwen of the Scripps Institution staff has been carrying on a special study of the amount of water poured down the course of the Colorado, the one great river that empties into it. It is hoped that this study will eventually make possible seasonal forecasts of the amount of water that can be expected to come down the river.

The seagoing research program of the Scripps Institution has involved constant use of the laboratory yacht *E. W. Scripps* over extended periods. Ten-day cruises were made from March to June of last year, starting every 16 days. This year's program calls for a cruise to start every 24 days.—FRANK THONE.

A NEW GERM-KILLING CHEMICAL

A CHEMICAL from the earth itself, the most powerful germ killer yet discovered, better even than the sulfa drugs themselves, has cured in a remarkably short time an array of difficult and dangerous human ills, according to reports from the Mayo Clinic and the Massachusetts Memorial Hospitals to the American Society for Clinical Investigation meeting in Atlantic City, N. J.

The new chemical is gramicidin. It is produced by bacteria that live in the soil. Its discovery was announced in 1939 by Dr. René J. Dubos, of the Rockefeller Institute for Medical Research, but the reports presented at the meeting are the first on the use of gramicidin in human patients.

Empyema from pneumonia, sinusitis, bladder infections and dangerous and hard-to-cure staphylococcus infections in wounds are the conditions that this new chemical remedy cured in remarkably short time. Infected wounds were freed of all bacteria within twenty-four hours after gramicidin treatment, following which the wounds rapidly healed, was reported by Dr. Charles H. Rammelkamp and Chester S. Keefer, of Boston. "This is a distinct advance inasmuch as former antiseptics would not rid the wound of bacteria without seriously damaging the tissues."

Sinus infections were cleared up within 48 hours, according to Dr. Wallace E. Herrell and Dr. Dorothy Heilman, of the Mayo Clinic. Severe bladder infections which the sulfa drugs do not affect were cured within one week. Gramicidin is the most highly effective agent yet discovered for stopping the growth of bacteria. Trials on twelve patients at the Mayo Clinic were reported in detail, although three more have also benefited from the new chemical.

It has one disadvantage. It breaks down red blood cells by the process called hemolysis. This toxic property of the new chemical remedy was discovered at the Mayo Clinic in experiments with the chemical on pieces of tissue growing outside the human body. A way was found to prevent this red blood cell-destroying action. It can be accomplished by heating the gramicidin. The heating, however, reduces its effect on the disease germs.

Gramicidin, therefore, can not be used, unless heat-treated, where it will come in contact with the blood. This means it is not suitable for injection into the veins. It can, however, be safely injected into such cavities as

the sinuses, the bladder, and infected but not bleeding wounds and any local infections such as ulcers. White blood cells, which are part of the body's defense against disease germs, are not harmed by gramicidin.

The potency of gramicidin is shown by the fact that one gamma, or one thousandth of a milligram, of the substance will stop the growth of virulent streptococcus and pneumonia germs in tissues. One milligram is the equivalent of slightly more than one hundredth of a grain. The strongest concentration of the material used in treating patients at the Mayo Clinic was 400 gamma per cubic centimeter.

HEPARIN

ONE of the greatest unsolved problems facing surgeons in their life-saving operations, the formation of peritoneal adhesions after operations inside the abdomen, may soon be conquered. Promising results in prevention of adhesions by heparin, the anti-blood clotting substance obtained from cows' lungs, were reported by Dr. Floyd Boys, assistant professor of surgery at the University of Virginia Medical School, at the meeting at Richmond of the Virginia Academy of Science.

Peritoneal adhesions, Dr. Boys pointed out, are one of the chief causes of the dangerous condition, intestinal obstruction. They result from the organization of an inflammatory exudate or juice lying between opposed injured surfaces of the peritoneum, which is the membrane lining the inside of the abdominal walls.

"At first the exudate is unclotted," Dr. Boys explained, "but it soon becomes coagulated and an adhesion composed of fibrin is formed. If, and when, the opposing peritoneal layers covering the organs in this zone are destroyed by inflammation, the exposed sub-peritoneal connective tissue and blood vessel elements are stimulated to proliferate (grow) over the fibrin which acts as a scaffolding. By this process, termed organization, the fibrinous adhesion is replaced by scar tissue and a permanent adhesion remains." Between one and two of every one hundred major abdominal operations, it is estimated, are performed for relief of intestinal obstruction due to such adhesions.

Many methods have been tried to prevent these adhesions during the one hundred and fifty years since the condition has been known. None, however, has proved satisfactory. When purified heparin was developed for prevention of dangerous clots within blood vessels, Dr. Boys and Dr. Edwin P. Lehman, professor of surgery at the University of Virginia, believed it might prevent adhesions also by preventing the coagulation of the inflammatory peritoneal exudate which is the starting point of adhesion formation.

Studies on rabbits and dogs were so promising that the heparin treatment for prevention of adhesions was used in a "few cases of intestinal obstruction" in humans "without any untoward effects." The chief danger in the use of heparin lies in the possibility of hemorrhage within the abdomen, but care during the operation to prevent bleeding from the small veins and arteries should eliminate this danger.

Dr. Boys pointed out that "an enormous number of cases must be treated with heparin before a sufficient number of cases will come to re-operation or post-mortem to offer a basis for judging the efficiency of the method employed. It would seem necessary, therefore, that primary acceptance of such a method must rest upon laboratory and animal assay evidence. If the experimental value of heparin in preventing peritoneal adhesions is confirmed by other investigators, its use should offer considerable promise for this heretofore essentially unsolved surgical problem."—JANE STAFFORD.

ITEMS

Special centers known as carotid bodies, that normally control the reactions of the blood vessels, have much to do with the violent convulsions that are typical symptoms of cyanide poisoning, according to a report presented at the recent meeting of the American Philosophical Society by Professor Carl F. Schmidt, of the University of Pennsylvania. In the carotid bodies, fine blood vessels are brought into intimate contact with groups of nerves. It has long been held that the chemical state of the blood produced effects on these nerves, and through the brain and other parts of the central nervous system these effects were reflected in all parts of the body. Thus, through strong poisons the carotid bodies can throw the whole body into convulsions. Professor Schmidt made a test of this by severing the nerve supply to these bodies in properly anesthetized laboratory animals. When sodium cyanide was injected into their veins, no convulsions occurred, despite the fact that the doses were rather large, though short of lethal size.

A link between patterns of mental behavior and the laws of other sciences were demonstrated at the meeting of the American Philosophical Society by Dr. Karl S. Lashley, of Harvard University. Thinking, perceiving and other mental activities, Dr. Lashley indicated, are associated with activities of the nervous elements in the brain's cortex which have many of the same characteristics of pattern or organization. Psychological study of how you perceive objects or happenings through signals from the eyes, ears or other sense organs reveals laws or organization identical with physical laws of force-fields. Electric potentials in the sensory areas of the brain point to complex interplay of interference patterns or of field forces. "Thus neurology and psychology are approaching a common formulation of the laws of organization of their materials. In studies of motivation and of the variables contributing to intellectual activity there is a similar confluence of the two disciplines toward a common statement of principles of organization."

ELEVEN lively, wriggling infants have been born to a female ball python at the Hershey Estates Zoological Garden at Hershey, Pa. This is a complete upset of a long-held zoological doctrine, still printed in all the books, that all pythons are egg-laying snakes, according to Ward Walker, director. Plenty of snakes bear their young alive, including such common species as water-snakes and garter-snakes, but until now the Old-World pythons had not been known to be anything but egg-layers. The ball python gets its name from its habit of rolling up into a compact ball when disturbed or frightened. It can then be rolled about rather roughly, but refuses to uncoil. Its native home is West Africa.